

IMPORTANT INFORMATION, PLEASE READ!!

Be advised that this exam has 323 total points, and is 50 minutes long.

- Please make sure your responses contain **only the answer**, especially for fill-in-the-blank. Most short answers are one word unless specified otherwise and use the official spellings of all taxa on the 2021 Fossils List. Identification questions are at the State/National level.
- We will be online from 6pm CST to 9pm CST on 10/23 and 12pm CST to 3pm CST on 10/24 to answer questions. Outside of these time ranges we cannot guarantee we will be available to answer questions, so try to schedule your entire 50-minute exam block to fit in these ranges if you anticipate asking questions to the event supervisors.
- This exam is open-note, closed-internet; **looking up information online is strictly prohibited and a violation of science olympiad ethics.**
- Questions marked with a * will be hand-graded (please still keep answers concise) and ^ marks a tiebreaker.
- **You are allowed a scientific calculator on this exam.**
- Brevity is your friend! Some questions require that you answer in "no more than one sentence", but really these can be answered with just a few words in most cases. This will help you answer questions faster. Don't worry about using improper grammatical conventions.

There are 18 "stations" on this exam but you are free to answer all questions in any order and progress at your own pace. Though the individual station timings are not enforced in any way, this is very much still a stations test in spirit. If you are taking too long on one station, don't hesitate to move on.

Good luck and have fun!

-Ryan Anselm (Clements '20) and Alisa Zhang (Mason '20)

Station 1: Geologic Time Scale

1. (1.00 pts)

Q #1-5: Identify time period based on description (answer with just the time period name).

This period is characterized by global cooling and drying, resulting in numerous glaciers in its following period. Tropical environments ceded to deciduous forests and herbivorous animals diversify due to increased grasslands. Numerous land bridges form and notable mountains ranges in East Asia, Western Europe, and the Western Americas are formed due to continental collisions.

Neogene

2. (1.00 pts)

This period is most well known for continental collisions, extremely large arthropods, and the fall of tropical rainforests. A few million years in the beginning of this time period have a significant gap in the fossils and this is most often associated with drop in atmospheric oxygen levels and potentially a severe reduction in carrying capacity.

Carboniferous

3. (1.00 pts)

Ice caps at the poles were not present in this time period. There were numerous monsoonal cycles which made the coasts extremely wet but interior land stayed warm and dry. There are many index fossils for this time period due to significant events before and after this period.

Triassic

4. (1.00 pts)

This time period was characterized by high sea levels and numerous groups of islands for diverse flora and fauna. While land animals did not diversify significantly in this period, many vertebrates and plants experienced prominent evolutionary changes. Unlike the periods before and after, this period had stable and warm temperatures due to high levels of CO₂ resulting in warm shallow seas and glaciers almost disappearing.

Silurian

5. (1.00 pts)

This time period involved atmospheric CO₂ levels similar to today, while the global temperature steadily increased throughout this period. Severe reduction of shallow marine environments decimated numerous species of marine animals while extensive deserts and seasonal rain cycles led to the diversification of gymnosperms across the globe. Amniotes also had increased success over anamniotes in light of dry conditions.

permian

6. (1.00 pts)

Q #6-7: Identify the era/eon based on the following description.

This era/eon is characterized by significantly more rifting continental activity than converging continental activity, unlike the preceding era/eon. Wildlife consisted of small mammals and large reptiles; plant life started with the diversification and success of gymnosperms, then later in the era/eon, the dominance of angiosperms over other types of plants.

Mesozoic

7. (1.00 pts)

This era/eon is characterized by oceans amidst extremely hot temperatures due to high atmospheric pressure and CO₂ levels. Eventually, global cooling occurred and a large amount of CO₂ dissolved in the ocean, while another portion of CO₂ was eliminated due to plate tectonics. The concluding events of this era/eon are the formation of solid rock and severe reduction of the greenhouse effect which changed the proportions of the atmosphere from being primarily CO₂.

Hadean

8. (1.00 pts) Q #8-12: Name the time period for these index fossils; if it is not an index fossil, write n/a:



Devonian

9. (1.00 pts)



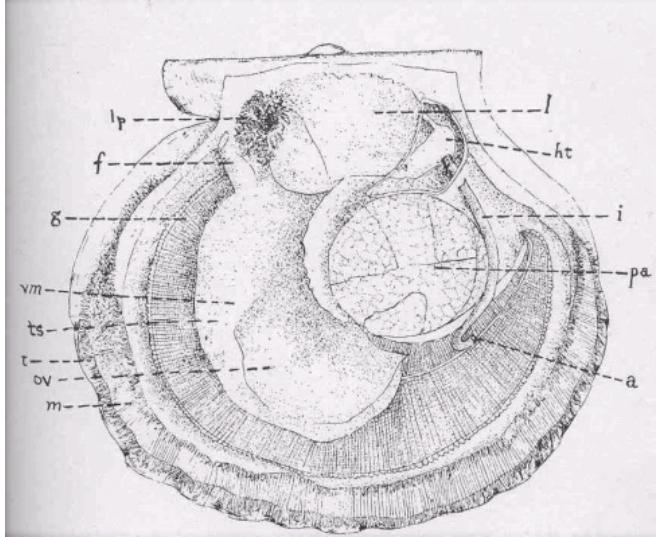
Jurassic

10. (1.00 pts)



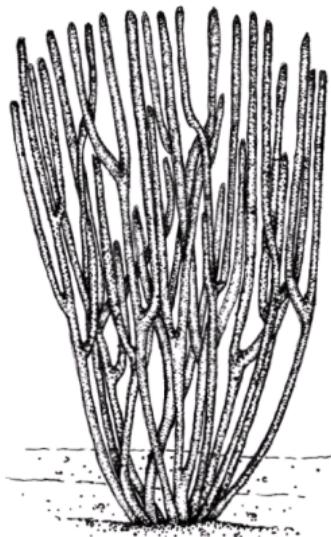
Ordovician

11. (1.00 pts)



Quaternary

12. (1.00 pts)



n/a

13. (4.00 pts) Select time periods which satisfy at least 3 out of the 4 following characteristics:

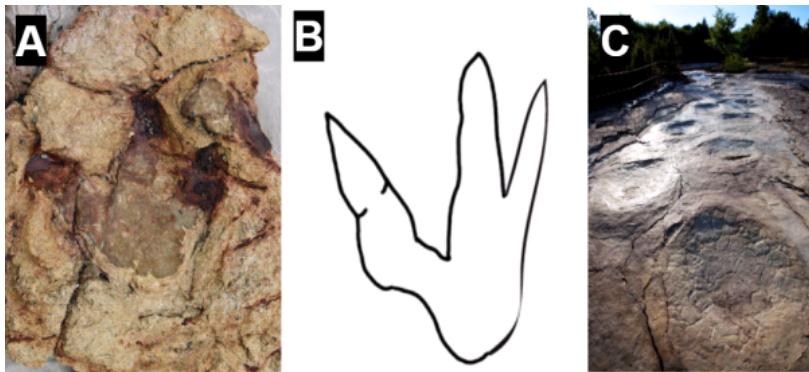
- Entirety of the time zone is before the opening of the South Atlantic Ocean
- Within Order Orthocerida's temporal range
- Contained atmospheric CO₂ levels above 2000ppm at any time through the period
- Immediately follows one of the 5 big mass extinctions

(Mark ALL correct answers)

- A) Ordovician
 B) Cretaceous
 C) Cambrian
 D) Jurassic
 E) Paleogene
 F) Permian

Station 2: terrible lizards

14. (3.00 pts)



For Images A-C, give the suborder/infraorder that corresponds with the track(s) shown. (A in blank #1, B in blank #2, C in blank #3)

Ornithopoda

Theropoda

Sauropodomorpha

15. (1.00 pts) Of the three groups identified, which one is most distantly related to the others?

- A) A
 B) B
 C) C

16. (1.00 pts) Ornithischians evolved this lower jaw bone to clip off plant material. (one word)

predentary

17. (1.00 pts) Preserved feathers have been discovered on fossils of velociraptor.

- True False

18. (3.00 pts)

It is unclear to paleontologists whether dinosaurs were endothermic (warm-blooded) or ectothermic (cold-blooded). Select all pieces of evidence which are supportive of endothermy.

(Mark ALL correct answers)

- A) Mesozoic climate conditions
 B) Evolutionary relation to birds
 C) Dinosaurs had weight-bearing limbs
 D) Some dinosaurs were extremely large

- E) Dinosaurs lacked respiratory turbinates
- F) Low predator-prey ratios

19. (1.00 pts) Q #19-22: Determine if the following statements about specimen D are true or false.



Specimen D was a predator.

- True False

20. (1.00 pts) Specimen D was an ornithischian.

- True False

21. (1.00 pts) Specimen D is more closely related to birds than ornithopods.

- True False

22. (1.00 pts) Specimen D has a pelvic girdle where the pubis and ischium run roughly parallel.

- True False

23. (1.00 pts)

A set of unknown theropod tracks is found. The trackway has a pace length of 50cm, and a foot length of 10.5 cm. Using the mysterious and somewhat sketchy wizardry of track math, determine whether this dinosaur was walking, trotting, or running.

- A) walking
 B) trotting
 C) running

Station 3: clams and impostor clams

24. (3.00 pts) Select all the choices which are correct for Class Bivalvia (yes this is basically a ginormous true/false question)

(Mark ALL correct answers)

- A) They lack organs which most other mollusks have, such as the radula and the odontophore.
- B) In species that burrow deeper into the sediment, the shell is rounder/more spherical to allow for easier movement.
- C) Some bivalves have evolved the ability to swim by rapidly opening and closing their valves.

D) Reproduction is typically through external fertilization, although some species are hermaphroditic.

E) They differ from brachiopods because brachiopods have bilateral symmetry.

25. (1.00 pts) Identify the brachiopod/mollusk based on its characteristic:

The name of this fossil means little tongue.

lingula

26. (1.00 pts) What mineral makes up the bristles (chaetae) bordering the valves of the shells from #25?

chitin

27. (1.00 pts) Identify the brachiopod/mollusk based on its characteristic:

Named after Constantine Samuel _____.

rafinesquina

28. (1.00 pts) What is the shape classification for the shell from #27?

concavo-convex

29. (2.00 pts) *Why does it have this classification? Give your answer in no more than one sentence.

Expected Answer: Ventral/pedicle valve curves inwards (1) while dorsal/brachial valve curves outwards (1)

30. (1.00 pts) Identify the brachiopod/mollusk based on its characteristic:

Named by James Sowerby.

astarte

31. (1.00 pts) The shells from #30 have no ribbing.

True False

32. (1.00 pts) Identify the brachiopod/mollusk based on its characteristic:

There is exposed rock in Germany with high concentrations of this brachiopod/mollusk named "Ermingen [insert variation of name here]."

Turritella

33. (1.00 pts)

^aThe name of this fossil is included in a type of agate with numerous shells. While the name has stuck, it is actually a different species altogether in this agate (it was incorrectly identified at first). What is the genus of the shells actually found in this agate?

elimia

34. (1.00 pts) Identify the brachiopod/mollusk based on its characteristic:

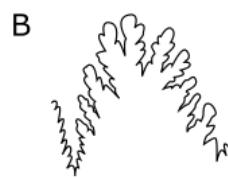
Has a symbiotic relationship with crinoids.

platyceras

35. (1.00 pts) What classification of symbiotic relationship does the specimen above have with crinoids?

- A) Ammensalism
- B) Commensalism
- C) Proto-cooperation
- D) Predation
- E) Neutralism
- F) Cannibalism

36. (3.00 pts) Identify the order associated with each suture. (A in blank #1, B in blank #2, C in blank #3)



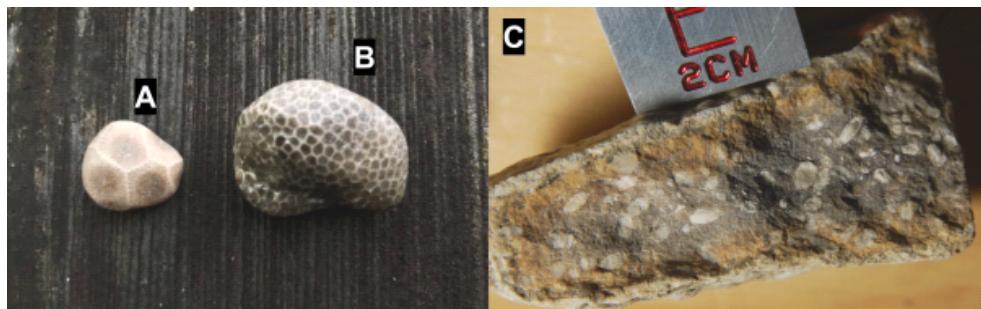
ceratitida

ammonitida

goniatitida

Station 4: coral and other friendos

37. (3.00 pts)



For Specimens A-C, identify the order.

rugosa

tabulata

fusulinida

38. (3.00 pts)



For specimens D-F, identify the order.

scleractinia

dendroidea

rugosa

39. (3.00 pts) Select all specimens whose order went extinct with or shortly before the P-T Extinction Event.

(Mark ALL correct answers)

- A) A
- B) B
- C) C
- D) D
- E) E
- F) F

40. (1.00 pts) Specimen A is known as a _____ stone.

petoskey

41. (1.00 pts) Specimen B is known as a _____ stone.

charlevoix

42. (1.00 pts) Q #42-45: Identify the element based on the description.

An anomalous abundance of this element was found in the K-Pg boundary.

iridium

43. (1.00 pts) Low seawater concentrations of this element inhibits aragonitic reef-building (as opposed to calcitic reef-building).

magnesium

44. (1.00 pts) Isotopic ratios of this element are measured in fossilized foraminifera as a proxy for ocean paleotemperatures.

oxygen

45. (1.00 pts) This element is proposed in the Canfield Ocean model to have blocked the deposition of BIFs (banded iron formations).

sulfur

46. (1.00 pts) What were the dominant reef-building organisms during the Late Cretaceous?

rudists

47. (1.00 pts) What were the dominant reef-building organisms during the Jurassic?

scleractinians

48. (1.00 pts) What were the dominant reef-building organisms during the Cambrian?

archaeocyathids

Station 5: carbon-14 was too easy

Answer the following questions about radiometric dating. (As stated in the rules, you are allowed a scientific calculator!)

49. (2.00 pts) Rb-87 decays to stable isotope Sr-87 with a half life of **48.8 billion years**. Calculate the decay constant in years⁻¹.

Give your answer in scientific notation with 3 sigfigs. ("#.## E#", example: "5.55 E-5")

1.42 E-11

50. (4.00 pts)

You measure a rock with a Rb-87/Sr-87 ratio of precisely **268.0**. Assume that there was no Sr-87 when the rock first crystallized and that the system has not exchanged any atoms with its surroundings since crystallization. How old is the rock?

Give your answer in mya with 3 sigfigs (example: "101 mya") Tip: It may be useful for the next steps to derive an equation relating [Sr-87] and [Rb-87].

262 mya

51. (5.00 pts)

Of course, it is wrong to assume that there was initially no Sr-87 in your rock. Instead, assume there was initially some nonzero amount. You find another rock of the same age from the same formation and take new isotope ratio measurements of both rocks. Your results are shown below.

Present Day Ratios	Sr-87/Sr-86	Rb-87/Sr-86
Rock 1	2.11	565.4
Rock 2	1.56	397.3

Assume that both systems have not exchanged any atoms with their surroundings since crystallization and that both **initially** had the same Sr-87/Sr-86 ratio. Also assume that all measurements are precise.

How old are rocks 1 and 2 actually? Give your answer in mya with 3 sigfigs (example: "101 mya")

230 mya

52. (3.00 pts) Calculate the initial Sr-87/Sr-86 ratio of the rocks.

Give your answer in scientific notation with 3 sigfigs. ("#.## E#", example: "5.55 E-5")

2.60 E-1

53. (2.00 pts)

*What is unique about Uranium-Lead dating that allows for several different radiometric dating methods involving uranium and lead? Give your answer in no more than one sentence.

Expected Answer: Uranium-Lead dating has two decay chains.

Station 6: ID sprint

Identify specimens A-T to the lowest taxonomical level given on the 2021 Fossils List. Each question will have three images. If it says identify A-C, for example, A goes in blank #1, B goes in blank #2, C goes in blank #3. Use only official names and spellings given on the 2021 Fossils List.

Multiple images grouped together in a red box correspond to the same specimen and should be identified together. If an answer is a species, write only the specific epithet (ex: "sapiens" NOT "H. sapiens"). There are no repeat answers within this station.

54. (3.00 pts)



Identify specimens A-C.

Eryops

Basilosaurus

Mesohippus

55. (3.00 pts)



Identify specimens D-F.

Otodus

Mammuthus

Pterosauria

56. (3.00 pts)



Identify specimens G-I.

Nautilida

Goniatitida

Plesiosauria

57. (3.00 pts)

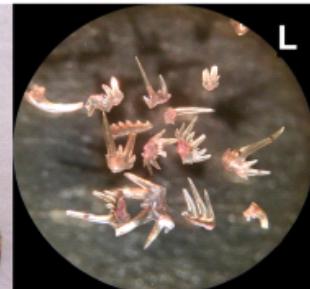


Identify specimens J-L.

Batoidea

Megalodon

Agnatha



58. (3.00 pts)



Identify specimens M-O.

Dimetrodon

Equus

Mammut

59. (3.00 pts)



Identify specimens P-R.

Mosasauridae

Acanthostega

Velociraptor

60. (2.00 pts)



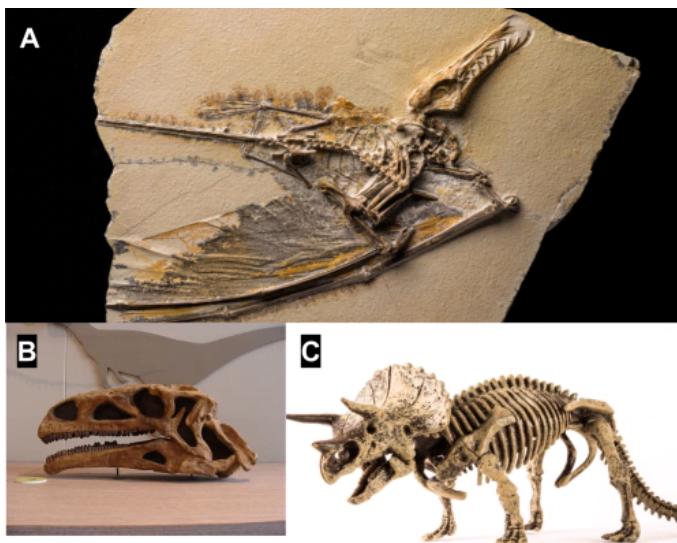
Identify specimens S and T.

Carcharodon

Selachimorpha

Station 7: hips don't lie

61. (3.00 pts)



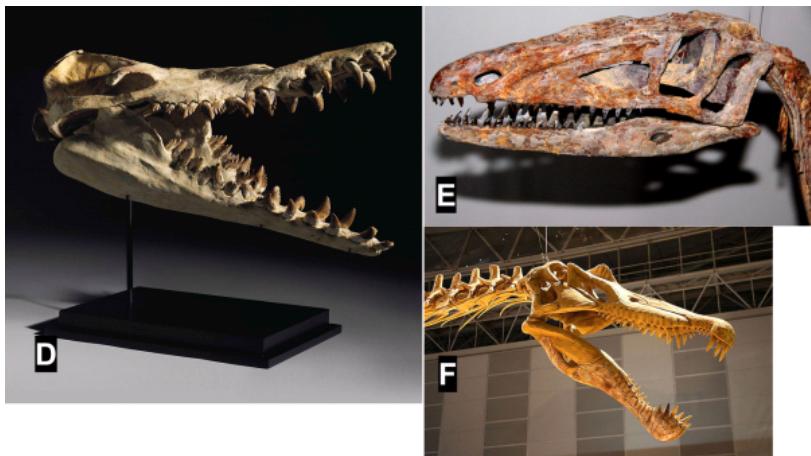
Identify specimens A-C.

Pterosauria

Plateosaurus

Triceratops

62. (3.00 pts)



Identify specimens D-F.

Basilosaurus

Coelophysis

Spinosaurus

63. (2.00 pts) Select all characteristics that apply for specimen A.

(Mark ALL correct answers)

- A) Bird-hipped
- B) Thecodont
- C) Heterodont
- D) Pleurodont
- E) Digitigrade
- F) Plantigrade

64. (2.00 pts) Select all characteristics that apply for specimen B.

(Mark ALL correct answers)

- A) Bird-hipped

- B) Thecodont
- C) Heterodont
- D) Pleurodont
- E) Digitigrade
- F) Plantigrade

65. (2.00 pts) Select all characteristics that apply for specimen C.

(Mark **ALL** correct answers)

- A) Bird-hipped
- B) Ovoviviparous
- C) Viviparous
- D) Herbivorous
- E) Digitigrade
- F) Plantigrade

66. (2.00 pts) Select all characteristics that apply for specimen D.

(Mark **ALL** correct answers)

- A) Oviparous
- B) Viviparous
- C) Heterodont
- D) Pleurodont
- E) Thecodont
- F) Aquatic

67. (2.00 pts) Select all characteristics that apply for specimen E.

(Mark **ALL** correct answers)

- A) Bird-hipped
- B) Thecodont
- C) Ziphodont
- D) Pleurodont
- E) Aquatic
- F) Herbivorous

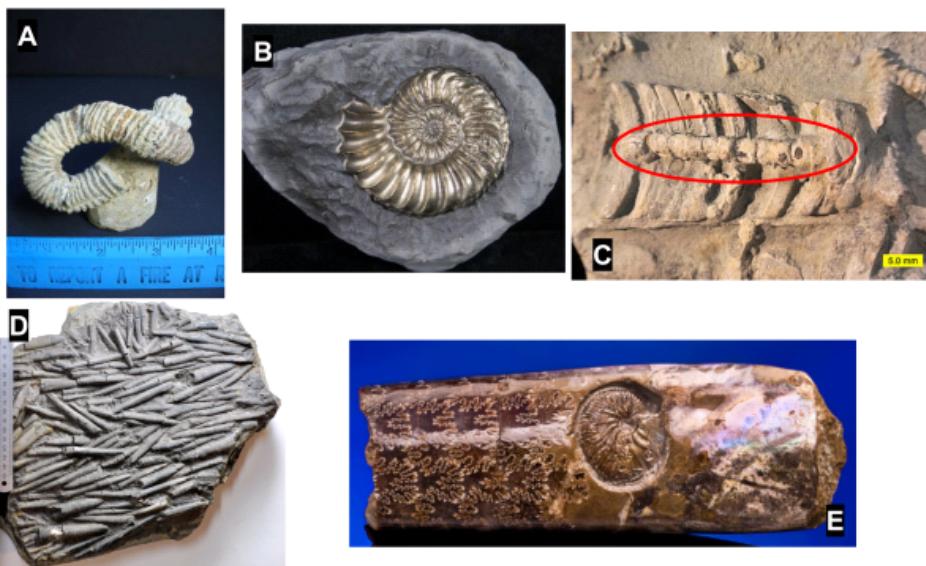
68. (2.00 pts) Select all characteristics that apply for specimen F.

(Mark **ALL** correct answers)

- A) Bird-hipped
- B) Ziphodont
- C) Aquatic
- D) Digitigrade
- E) Plantigrade
- F) Unguligrade

Station 8: *insert cephalopod joke here*

69. (2.00 pts)



Refer to specimens A-E to answer the following questions.

Select all of the following which are considered ammonoids.

(Mark **ALL** correct answers)

- A) A
- B) B
- C) C
- D) D
- E) E

70. (1.00 pts) Which specimen is most closely related to the modern species *Nautilus*?

- A) A
- B) B
- C) C
- D) D
- E) E

71. (1.00 pts) Which specimen is used as a proxy to measure oceanic paleotemperatures?

- A) A
- B) B
- C) C
- D) D
- E) E

72. (1.00 pts) What is the shell morphology of specimen A? (NOT suture pattern)

heteromorph

73. (1.00 pts) What mineral causes the golden coloration of specimen B?

pyrite

74. (1.00 pts) What is the structure circled in red on specimen C?

75. (2.00 pts) *What is the primary means of distinguishing between species of specimen D? Give your answer in no more than one sentence.

Expected Answer: Examining the hook structure

bioimmuration

76. (1.00 pts) What preservational phenomenon does specimen E display? (Specifically, the preservation related to the smaller organism embedded in the larger.)

aragonite

78. (1.00 pts) The intricate patterns seen on the side of specimen E were used for sexual selection.

True False

79. (4.00 pts)

*Mass accumulations of Specimen D remains like the one shown are quite common. Give two pathways that might lead to the formation of these accumulations. Each pathway should be described in no more than a sentence.

Expected Answer: Accept two of any of the following (2 points each): Post-spawning mortality, catastrophe mass mortality, predation concentration, stratigraphic condensation, resedimentation.

Station 9: i liked carbon before it was coal

80. (1.00 pts)



What type of rock is the upper layer in image A? (not sedimentary/metamorphic/igneous, identify the rock)

sandstone

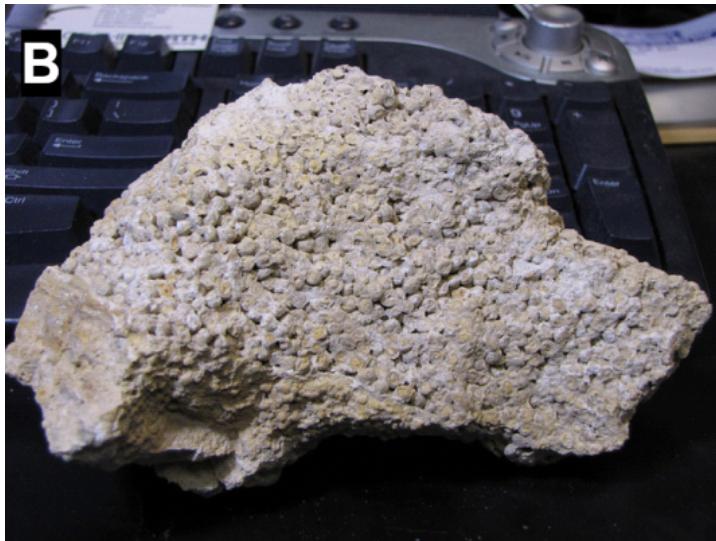
81. (1.00 pts) The lower layer in image A comes from the early Proterozoic and consists of metamorphic and igneous basement rock. What type of unconformity is depicted?

nonconformity

82. (0.00 pts) ^The unconformity shown in image A is famous because it represents an abrupt gap between the Proterozoic and Phanerozoic. Where is it located? (2 words)

Grand Canyon

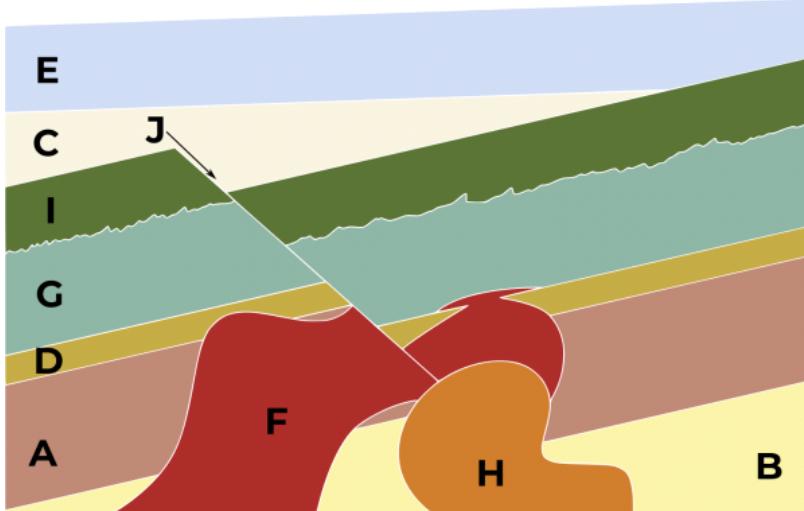
83. (1.00 pts)



Identify the rock in the image B.

limestone

84. (4.00 pts)



*Order the letters in the stratigraphic section from youngest to oldest, starting with H as the youngest. (Give your answer as a string of letters, ex: "HABCDEFGLIJ")

Expected Answer: HECJIGFDAB

85. (1.00 pts) If the depositional environment was a lagoon when layer C was being formed, what type of rock (out of the rocks on the list) is layer C most likely to be?

shale

86. (1.00 pts) What is the name of the unconformity between layers I and G?

disconformity

87. (1.00 pts) Suppose there was a gap in time but no visible erosion between layers I and G; what type of unconformity would this be?

paraconformity

88. (3.00 pts) Select all of the following statements which are true about zircons.

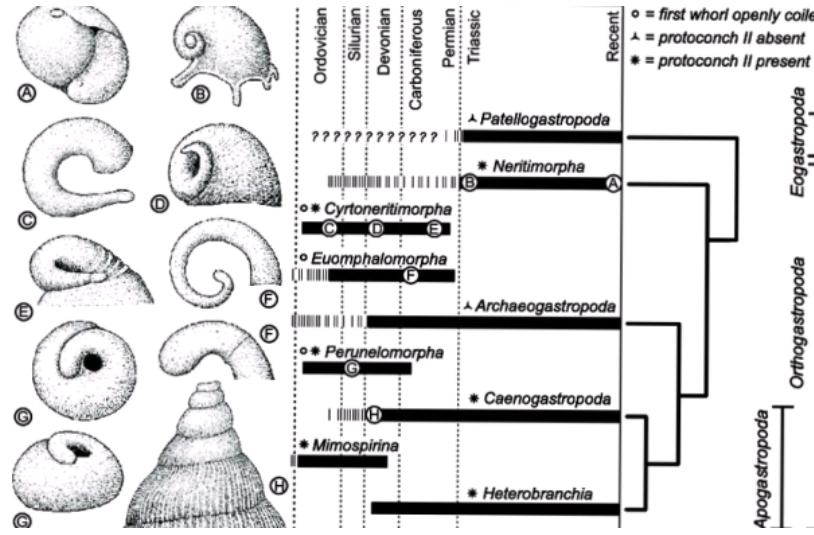
(Mark ALL correct answers)

- A) When zircons crystallize they incorporate both uranium and lead into their crystal structure, allowing for radiometric dating.
- B) Zircon dating does not actually give the age of deposition; it only provides a lower bound of age.
- C) Zircons lose their regular crystal structure due to radioactive damage.
- D) Zircon dating is useful for rocks under 50,000 years old.
- E) Concordia diagrams are used to date zircons

Station 10: definitely not the cambrian explosion

89. (2.00 pts) This station is about transitions! Answers are the full names of the transition event given.

Identify the transition event pictured below (fyi it is not the Cambrian Explosion):



great ordovician biodiversifi

90. (1.00 pts) Q #90-93: Answer the following true/false questions regarding the event identified in #89.

This event involved a shift in reefs from primarily microbes to multicellular organisms.

- True False

91. (1.00 pts) Benthos evolved into pelagic modes of life in large numbers during this event.

True False

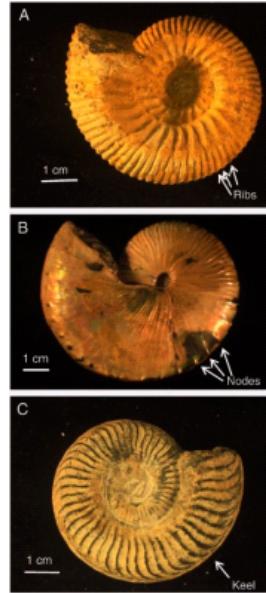
92. (1.00 pts) A decrease in biodiversity during the Furongian epoch is very well-documented.

True False

93. (1.00 pts) This event involved extensive adaptive radiation and consequential speciation in lower taxonomic levels.

True False

94. (2.00 pts) Identify the transition event pictured below:



mesozoic marine revolution

95. (1.00 pts) Q #95-98: Answer the following true/false questions regarding the event identified in #94

This event led to increased suspension feeders living on the ocean floor's surface.

True False

96. (1.00 pts) The rifting of Pangea is hypothesized to have contributed to this event

True False

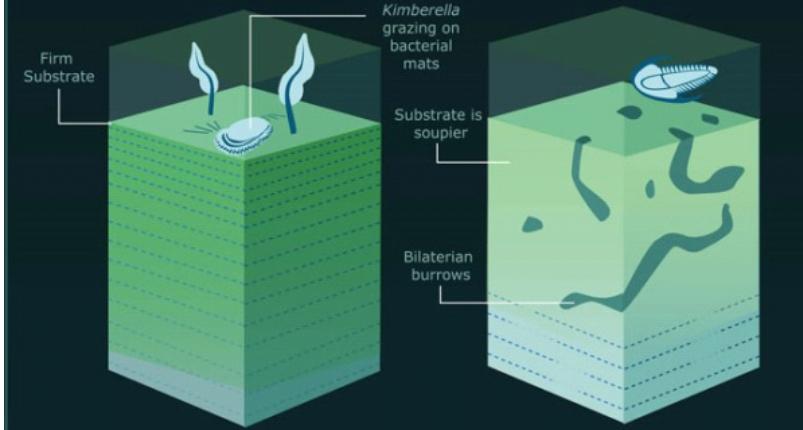
97. (1.00 pts) Predation pressure on hard-shelled animals was responsible for this event.

True False

98. (1.00 pts) This event took place in both deep and shallow marine environments.

True False

99. (2.00 pts) Identify the transition event pictured below (still not the Cambrian Explosion):



cambrian substrate revolution

100. (1.00 pts) Q #100-103: Answer the following true/false questions regarding the event identified in #99.

This event involved a shift to more firm soils suited for holding the shapes of burrows.

- True False

101. (1.00 pts) Seafloor soil makeup shifted from being in layers to being generally homogenous.

- True False

102. (1.00 pts) Echinoderms shifted from attaching to hard substrates to softer soils as a result of greater bioturbation.

- True False

103. (1.00 pts) An increase in horizontal digging led to a decrease in microbial mats during this event.

- True False

Station 11: were they acquaintances?

This station asks about whether two specimens would have coexisted!

- For the first part of each question, answer **True** if they coexisted with each other, and **False** otherwise.
- For the second part of each question, if they did coexist list **one specific continent/body of water** where the two specimens coexisted (example answers: "pangaea", "north america") (locations can be anywhere from 1-3 words long). If they did not interact, list the primary factor of separation between them: "*time*" or "*location*". If the specimens are separated by both factors, write "*time+location*".

104. (1.00 pts) Allosaurus and Stegosaurus

- True False

105. (1.00 pts) location/factor of separation?

North America

106. (1.00 pts) Iguanodon and Parasaurolophus

- True False

107. (1.00 pts) location/factor of separation?

time

108. (1.00 pts) *Titanis* and *Australopithecus*

- True False

109. (1.00 pts) location/factor of separation?

location

110. (1.00 pts) *Equus* and *M. primigenius*

- True False

111. (1.00 pts) location/factor of separation?

Asia

112. (1.00 pts) *Mosasauridae* and *Ichthyornis*

- True False

113. (1.00 pts) location/factor of separation?

western interior seaway

114. (1.00 pts) *Smilodon* and *H. erectus*

- True False

115. (1.00 pts) location/factor of separation?

location

116. (1.00 pts) Class Amphibia and Plesiosauria

- True False

117. (1.00 pts) location/factor of separation?

location

118. (1.00 pts) *Knightia* and Ichthyosauria

- True False

119. (1.00 pts) location/factor of separation?

time+location

120. (1.00 pts) Tyrannosaurus and Triceratops

True False

121. (1.00 pts) location/factor of separation?

laramidia

122. (1.00 pts) Basilosaurus and Otodus

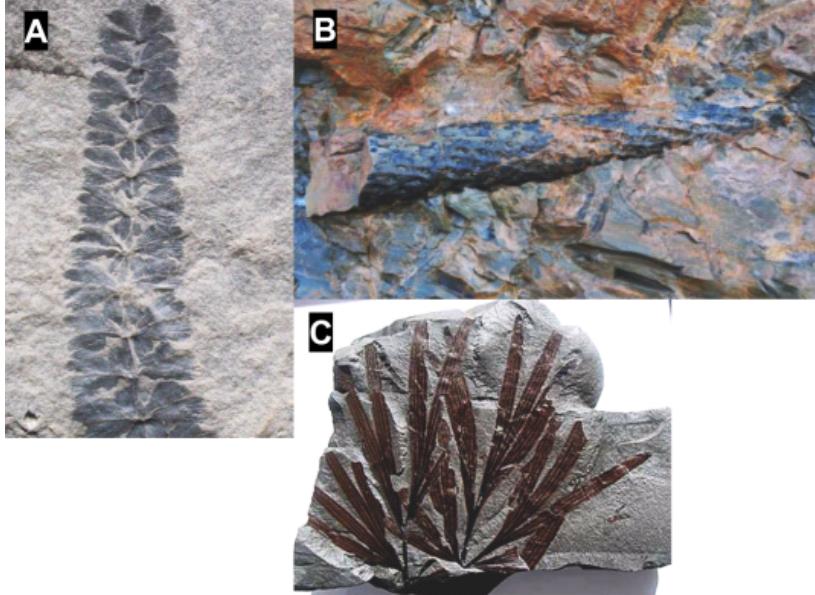
True False

123. (1.00 pts) location/factor of separation?

tethys sea

Station 12: plants! :)

124. (3.00 pts)



For specimens A-C, identify the phylum. (Hint: No phylum should be an answer more than once)

Sphenophyta

Lycopodiophyta

Ginkgophyta

125. (3.00 pts)



For specimens D-F, identify the phylum. (Hint: No phylum should be an answer more than once)

Pteridospermatophyta

Pteridophyta

Anthophyta

126. (2.00 pts) For specimens E and F, identify the true genus.

Psaronius

Populus

127. (2.00 pts)



For specimens G and H, identify the true genus.

Metasequoia

Calamites

128. (3.00 pts) List all of the specimens which can be found in the Mazon Creek fossil beds.

Give your answer as a list in alphabetical order like “abcd” or “bdfh”. No credit will be given unless completely correct.

abdeh

129. (3.00 pts) List all of the specimens which possess a clonal growth habit.

Give your answer as a list in alphabetical order like “abcd” or “bdfh”. No credit will be given unless completely correct.

fh

130. (2.00 pts) Select all of the following which did NOT first occur in the Devonian.

(Mark **ALL** correct answers)

A) Colonization of land by plants

- B) Emergence of a tree-like growth habit
- C) Evolution of roots
- D) Evolution of flowering plants
- E) Evolution of seeds

131. (1.00 pts) Pteridospermatophyta would be best described as a _____.

- A) Monophyletic group
- B) Paraphyletic group
- C) Cyclic group
- D) Wastebasket taxon
- E) Form taxon

132. (2.00 pts) What Paleozoic event ended cosmopolitan distribution of land animal species and led to amniotes outcompeting amphibians? (three word answer)

carboniferous rainforest coll

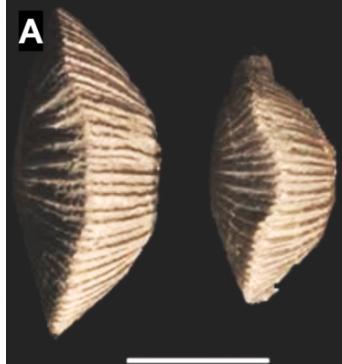
133. (3.00 pts) *How would fossil pollen be extracted from a mix of microfossils also containing diatoms and foram? What makes pollen grains resistant to this procedure?

Expected Answer: Something about use of strong acids/bases or chemical digestion. (1) The coating of pollen grains is made of sporopollenin, a highly resistant biopolymer.

Station 13: ID sprint revamped

Identify specimens A-W to the lowest taxonomical level possible given on the 2021 Fossils List. Each question will have three images. If it says identify A-C, for example, A goes in blank #1, B goes in blank #2, C goes in blank #3. For fossil specimens, use only official names and spellings given on the 2021 Fossils List. If a specimen is a **pseudofossil** write "pseudofossil" and if a specimen is a rock/other earth material write the name of the rock (ex: "*limestone*", "*coprolite*").

134. (3.00 pts)



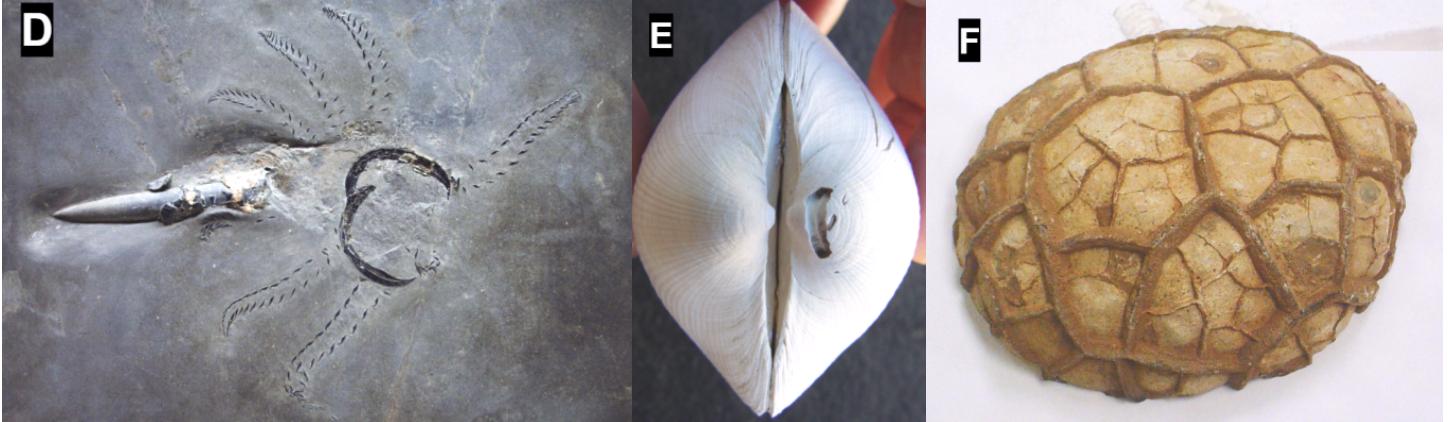
Identify specimens A-C.

Platystrophia

Favosites

Crinoidea

135. (3.00 pts)



Identify specimens D-F.

Belemnitella

Glycymeris

Pseudofossil

136. (3.00 pts)



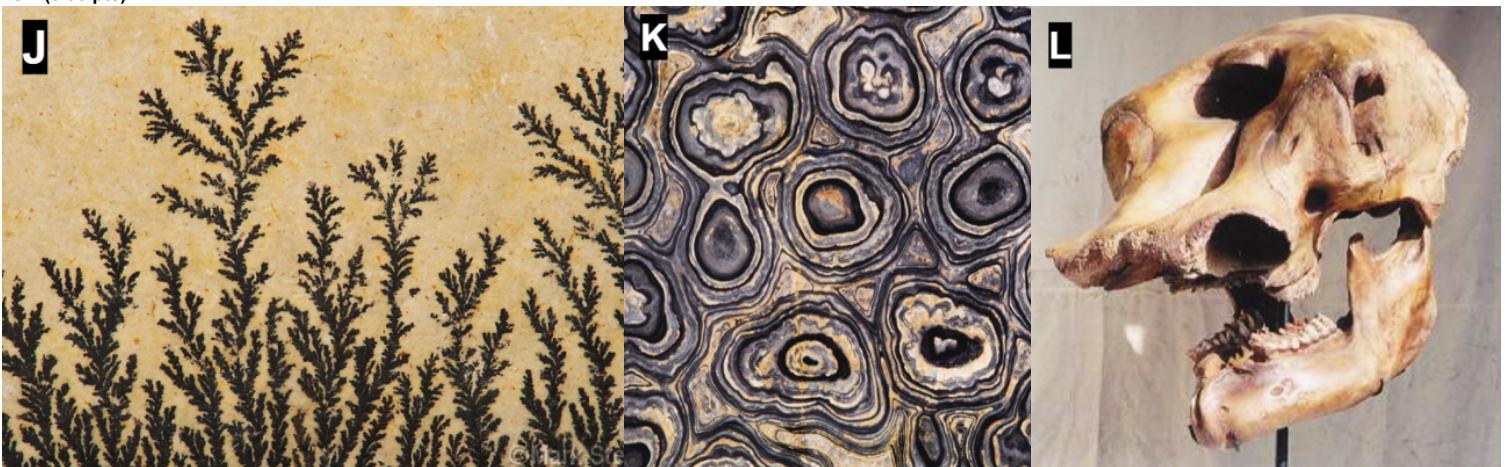
Identify specimens G-I.

Coquina

Chelicerata

Asteroidea

137. (3.00 pts)



Identify specimens J-L.

Pseudofossil

Stromatolite

Mammut

138. (3.00 pts)



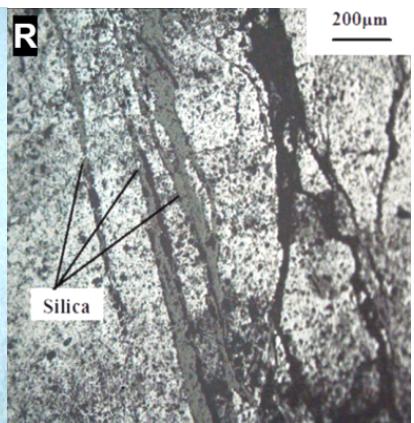
Identify specimens M-O.

Crustacea

Mesohippus

Nummulites

139. (3.00 pts)



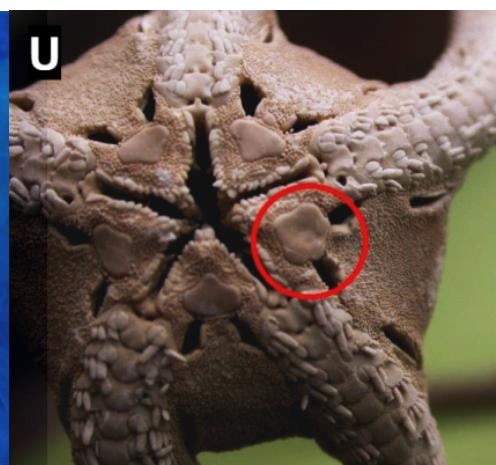
Identify specimens P-R.

Pseudofossil

Echinoidea

Chert

140. (3.00 pts)



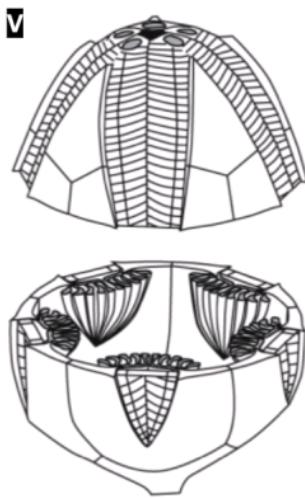
Identify specimens S-U.

Brachiosaurus

Xiphactinus

Ophiuroidea

141. (2.00 pts)



Identify specimens V and W.

Pentremites

Latimeria

Station 14: *record scratch* *freeze frame* you're probably wondering how i got here

This station is about fossils that were preserved in the middle of unique and interesting behaviors they exhibited in life.

142. (1.00 pts)

A



Identify Specimen A.

ichthyosauria

143. (1.00 pts) What probably caused this specimen's death? (one word)

childbirth

144. (2.00 pts) Which of the following are true/inferred about Specimen A?

(Mark ALL correct answers)

- A) The earliest fossils were born headfirst.
- B) These animals were ovoviparous.
- C) Being a reptile, Specimen A breathed through gills.
- D) Specimen A was a mesopredator.

145. (1.00 pts)

B

What lagerstätten does Specimen B come from? (proper capitalization for the name) (multiple word answer)

Ghost Ranch

146. (1.00 pts) Identify the taxon present in Specimen B.

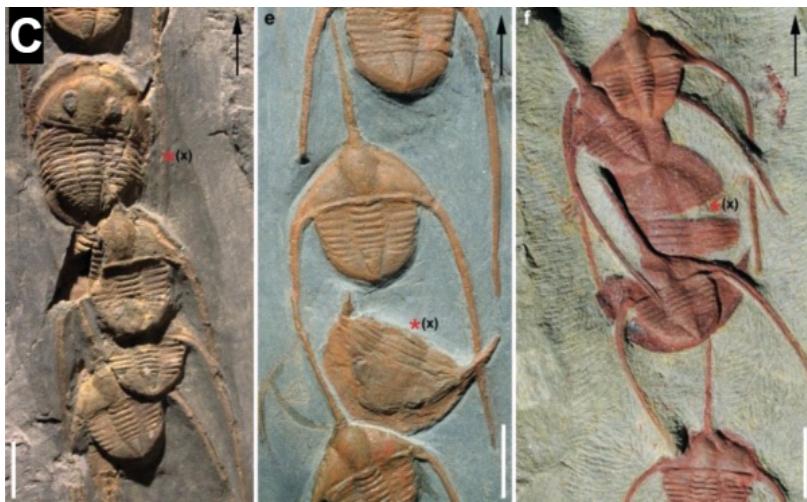
coelophysis

147. (2.00 pts) Which of the following are true/inferred about Specimen B?

(Mark ALL correct answers)

- A) This specimen reveals that they guarded their young.
- B) Specimen B were omnivorous animals.
- C) This specimen reveals they traveled in herds.
- D) A flash flood caused their death and fossilization.

148. (1.00 pts)

C

Identify the class of Specimen C.

trilobita

149. (2.00 pts) Which of the following are true/inferred about Specimen C?

(Mark ALL correct answers)

- A) They were migrating seasonally to a breeding ground.
- B) Lining up tail to head reduced drag.

- C) Specimen C was killed and fossilized by a landslide or avalanche.
- D) This movement was triggered by environmental changes.

150. (2.00 pts)



Knowing that Specimen D is a blood engorged mosquito, which of the following is true?

(Mark ALL correct answers)

- A) This fossil is encased in amber.
- B) The mosquito was preserved after falling to the bottom of a lake.
- C) DNA sequencing from the blood has identified it to be from Megacerops.
- D) The presence of heme and iron show the mosquito had just fed.

151. (2.00 pts)



Which of the following are true for Specimen E (the remains of the smaller animal in the image)?

(Mark ALL correct answers)

- A) This meal led to the death of the larger animal in the image.
- B) Their name comes from belemnion, meaning dart in Greek.
- C) The rings of growth in their cross section are annual.
- D) They are an apex predator.

152. (1.00 pts) How would the larger animal deal with the indigestible parts of the smaller animal in Image E?

regurgitation

Station 15: *sad isopod noise*

When your skeleton is on the outside
but no one notices during spooktober



153. (1.00 pts)



Identify Specimen A.

elrathia

154. (1.00 pts) What type of facial suture did Specimen A have?

opisthoparian

155. (1.00 pts) The facial sutures split open during molting, helping the trilobite exit the old exoskeleton.

True False

156. (2.00 pts) Which of the following is true about trilobites?

(Mark ALL correct answers)

- A) Longer genial spines are associated with a filter feeding diet.
- B) The thorax houses the stomach, limbs, and gills.

- C) Each type of facial suture is monophyletic
- D) The majority of fossils are just the molts, not the actual trilobite.
- E) The earliest trilobites had simple eyes with just one lens.

157. (1.00 pts)



Identify Specimen B.

calymene

158. (1.00 pts) What type of eye did Specimen B have?

holochroal

159. (1.00 pts) How many corneal layers did Specimen B have? (Give a number, ex: "0")

1

160. (1.00 pts) What shape is the cross-section of a lens in the eye type from Q158?

hexagon

161. (1.00 pts) What was the last period this specimen's class existed in?

permian

162. (0.00 pts) ^What is the trilobite named after Star Wars? (scientific name, don't abbreviate the genus)

han solo

163. (1.00 pts)



Identify Specimen C (all 3 photos correspond to this specimen).

eurypterida

164. (1.00 pts) What is the name of the simple eyes on the carapace?

ocelli

165. (1.00 pts) What process signified the end of one instar stage?

ecdysis

166. (1.00 pts) *In 2005, a terrestrial trackway for this fossil was discovered in Scotland deposits. What did this reveal about Specimen C?

Expected Answer: eurypterids could move/survive out of the water

167. (2.00 pts) What are the two types of propulsion for Specimen C? List the more common one first.

rowing

underwater flying

Station 16: interior crocodile alligator

168. (3.00 pts)



Identify specimens A-C.

Crocodylia

Lystrosaurus

Pterosaura

169. (2.00 pts)



Identify specimens D and E.

Archaeopteryx

Tiktaalik

170. (2.00 pts) Specimen D is a transitional fossil from _____ to _____ (both one word).

Dinosaur

Bird

171. (2.00 pts) Specimen E is a transitional fossil from _____ to _____ (both one word).

Fish

Tetrapod

172. (2.00 pts) Select all of the specimens that are archosaurs.

(Mark **ALL** correct answers)

A) A

B) B

C) C

D) D

E) E

173. (1.00 pts) Answer the following questions about the adaptations of specimens A-C.

Consider the snout of specimen A. Diet-wise, what lifestyle is it adapted for? Your answer should be more specific than just "carnivore". (one word)

piscivore

174. (1.00 pts) What behavior did specimen B use its powerful forelimbs for? (one word)

Burrowing

175. (1.00 pts) The fibers found on specimen C — known as pycnofibers — bear what relation to modern feathers?

- A) Homologous structure
- B) Convergent structure
- C) Ancestral form

176. (2.00 pts) *What is the main functional difference between conical and serrated teeth?

Expected Answer: Conical teeth are generally used to puncture (1), serrated teeth are used to rip/tear. (1)

//

177. (0.00 pts) *^Which is objectively cooler, Specimen D or Specimen E? (Give the specimen name)

Tiktaalik

Station 17: opabinia snip snip c o l l e c c dorit



178. (4.00 pts)

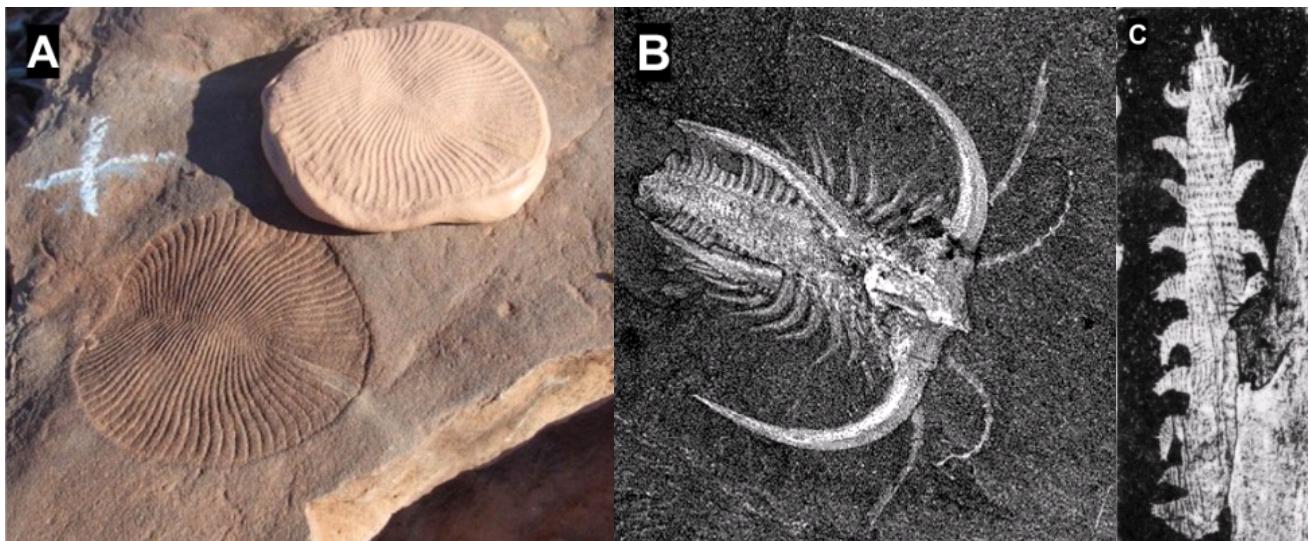
Answer the following questions about the Burgess Shale and the Ediacaran/Cambrian.

*The Burgess Shale was formed at the base of a steep submarine cliff. How did this feature enable rare soft-body preservation? During the millions of years after deposition, what processes did this same feature protect the Burgess Shale from?

Expected Answer: Mudflows would have rapidly buried the organisms at the base of the cliff. (2) Tectonic squeezing/distortions (2)

//

179. (6.00 pts)



*Classify the biota in images A-C as **Ediacaran** or **Cambrian** and give your reasoning in no more than one sentence for each.

Your answer should be formatted as:

"A: Ediacaran/Cambrian, because ..."

B: Ediacaran/Cambrian, because ..."

C: Ediacaran/Cambrian, because ..."

Expected Answer: A: Ediacaran (1); Image A is of Dickinsonia. Has a very different body plan from that of anything from the Cambrian onwards. (1) B: Cambrian (1); Image B is of *Marrella*, most common animal in the Burgess Shale, was arthropod or arthropod-like, related to trilobites. (1) C: Cambrian (1); Image C is of a lobopodian. Has legs so it cannot be from the Ediacaran. (1) Note: accept other reasonable explanations too, these are just the most direct rationales in my opinion. Competitors emphatically do NOT need to identify to get the explanation point. (as long as their reasoning make sense it's probably acceptable)

180. (2.00 pts)

Despite Ediacaran biota being exclusively soft-bodied, their preservation is global and surprisingly abundant. What widespread feature of the Ediacaran substrate made soft-bodied preservation possible? (two word answer)

Microbial mats

181. (3.00 pts)

*Briefly explain why soft-bodied organisms stopped getting fossilized except in rare cases of lagerstätte after the Cambrian. Give your answer in no more than one sentence.

Expected Answer: The Cambrian Substrate Revolution (1) was an increase in animal burrowing behavior and bioturbation (1) that caused the disappearance of microbial mats (1) from most environments.

182. (2.00 pts) What are the two most represented modern phyla in the Burgess Shale?

(Mark **ALL** correct answers)

- A) Chordata
- B) Arthropoda
- C) Brachiopoda
- D) Porifera
- E) Mollusca
- F) Bryozoa

183. (1.00 pts) From the early to mid Cambrian there was an apparent major decline in what mode of mineral preservation?

- A) Pyritization
- B) Carbonization
- C) Phosphatization
- D) Silicification

184. (2.00 pts) *What is significant about detecting cholesterol as a molecular fossil? Give your answer in no more than one sentence.

Expected Answer: Indicates metazoan (animal) life

Station 18: an atmospheric history of the earth

185. (3.00 pts) Rank the following years from highest to lowest atmospheric O₂ concentration. (Answer with a string of lowercase letters like “abcde”)

- a: 3.0 Ga
- b: 1.5 Ga
- c: 390 Ma
- d: 300 Ma
- e: Present day

decba

186. (1.00 pts) What worldwide climate event is hypothesized to be a consequence of the evolution of oxygenic photosynthesis? (two word answer)

snowball earth

187. (2.00 pts)

*It is thought that Earth's atmospheric CO₂ levels were higher in the Archean. What offsetting effect is thought to have allowed liquid water (and by extension, the first life) to exist on Earth's surface in spite of the enhanced greenhouse effect?

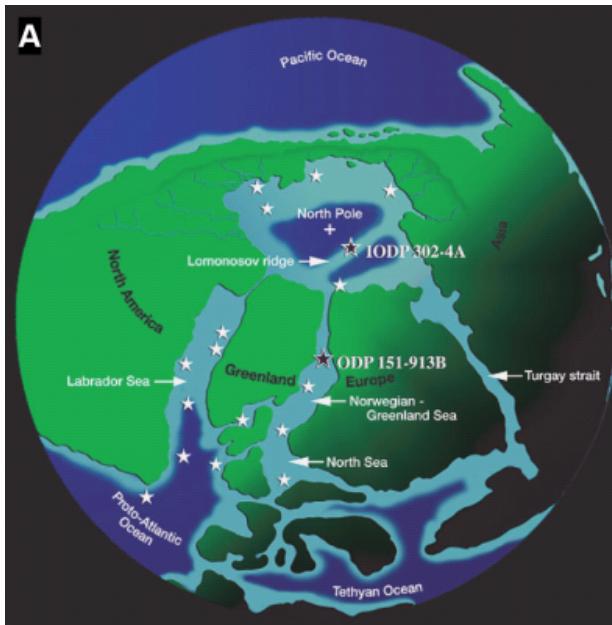
Expected Answer: Accept anything about lower solar luminosity.

188. (4.00 pts)

*Paleontologists have hypothesized atmospheric oxygen levels from the Silurian onwards to be constrained within a window of 13% to 35%. Briefly explain what the basis for this constraint is and what evidence is present to support it. (Basically explain why it couldn't be lower than 13% and couldn't be higher than 35%)

Expected Answer: Fire. (1) There is a fossil record of charcoal (1) indicating wildfires from the Silurian onwards. Below 13% oxygen concentration, fires will not ignite and spread (1) and above 35% oxygen concentration plants may burn irrespective of fuel moisture so no fire could be extinguished. (1)

189. (1.00 pts)



What epoch is depicted in image A?

Eocene

190. (1.00 pts) Which answer is closest to the change in average Arctic sea surface temperatures from the early part of this epoch to the present?

- A) +2 °C
- B) -2 °C
- C) +5 °C
- D) -5 °C
- E) +20 °C
- F) -20 °C

191. (1.00 pts)



What is specimen B?

Metasequoia

192. (3.00 pts)



*Briefly explain the significance of specimen C.

Be sure to mention an event, what the result of the event was, and the long term effects.

Expected Answer: The specimen is Azolla, and it was responsible for the Azolla event (1) where a superbloom of it in the Arctic Ocean led to extreme drawdown of CO₂ from the atmosphere (1), transforming the earth to a colder climate. (1)

193. (4.00 pts) *Briefly describe where specimen B and specimen C could be found latitudinally on image A.

Expected Answer: Specimen B could be found all the way up to around the Arctic circle/ at very high latitudes. (2) Specimen C could be found in blooms on a freshwater surface layer of the Arctic Ocean. (2)

194. (1.00 pts) Earth is currently in a greenhouse state.

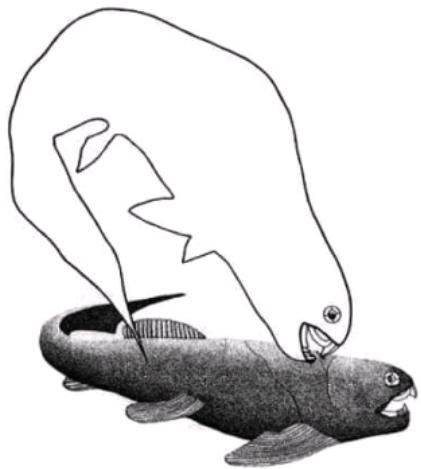
True False

Thank you for competing in Fossils! Please fill out this form (<https://forms.gle/P5ZH4PguZrc7uZCw6>) to give us feedback on the test and good luck on your remaining events :D

official feedback form: <https://forms.gle/dAVSu4PkxJPqr3qc6> (<https://forms.gle/dAVSu4PkxJPqr3qc6>)

de-stress: <https://frostdragonliz.itch.io/c-o-l-l-e-c-c> (<https://frostdragonliz.itch.io/c-o-l-l-e-c-c>) (<https://frostdragonliz.itch.io/c-o-l-l-e-c-c>)

**You have been visited by
the Spooky *Dunkleosteus* bitey ghost!**



**Comment “My armor is too thick with
calcium for your bites” or be
forever haunted!**